

Provisional Patent Application of

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for

HOOK-FLASH SIMULATION IN PARALLEL WITH OFF-HOOK DEVICES

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U. S. Provisional Patent Application Ser. Nr. 60/235,448, Filed September 26, 2000.

BACKGROUND-FIELD OF THE INVENTION

This invention relates to the effective simulation of a hook-flash on a signal loop without opening the loop and despite the presence of a number of off-hook devices on that loop.

GLOSSARY

The term "**cycled**", as applied to the contact devices shown in the drawings, is intended to mean: "opened for a predetermined time interval, then re-closed" for normally-closed devices; and "closed for a predetermined time interval, then re-opened" for normally-open devices.

The term "**counter-signal source**" is intended to refer to a signal source that, when connected to a loop and algebraically summed with that loop's supervisory signal source, is capable of creating a threshold breach.

The term "**hook-flash**" is intended to describe the timed threshold breach of a loop's supervisory signal.

The term "**loop**" is intended to refer to any circuit incorporating a supervisory signal circuit, typically including a supervisory signal source, a supervisory current threshold detector, any number of supervised devices connected to that circuit, the wiring necessary to interconnect those elements in a circuit, and the impedance inherent in that circuit.

The term "**loop current**" is intended to mean the supervisory signal current passing through a loop's supervisory signal current detector.

The term "**supervised**" is intended to apply to any device that is connected to a loop and, when connected as the only supervised off-hook device on that loop, is capable of causing a threshold breach.

The term "**supervisory**" is intended to describe anything contributing to the ability to detect a threshold breach on a loop.

The term "**supervisory signal**" is intended to mean any signal placed on a loop for supervisory purposes.

The term "**threshold breach**" is, generally, intended to imply the detectable change in value of a supervised parameter from one side of a detection threshold to the other. It is intended herein to imply a detectable change in the value of a supervised electrical current from one side of a current detection threshold to the other.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram illustrating a basic supervisory loop with supervisory signal current feeding a single supervised device.

FIG. 2 is a block diagram illustrating a basic supervisory loop with a loop current having component currents feeding a multiplicity of supervised devices, and having a contact device in series with the multiplicity of supervised devices.

FIG. 3A and **FIG. 3B** are block diagrams, each illustrating a basic supervisory loop with a loop current, having component currents feeding a multiplicity of supervised devices, and having a contact-controlled counter-signal source connected in parallel with the multiplicity of supervised devices. In **FIG. 3A**, the counter-signal source is disconnected from the loop, because the contact device in series with it is open. In **FIG. 3B**, the counter-signal source is connected to the loop, because the contact device in series with it is closed.

FIG. 4 and **FIG. 4B** are block diagrams, each illustrating a basic supervisory loop with a loop current, having component currents feeding a multiplicity of supervised devices, and having a contact-controlled counter-signal source connected to the loop conductors at a point in the loop at a distance from the multiplicity of supervised devices. In **FIG. 4A**, the counter-signal source is disconnected from the loop, because the contact device in series with it is open. In **FIG. 4B**, the counter-signal source is connected to the loop, because the contact device in series with it is closed.

LIST AND DESCRIPTIONS OF DRAWING ITEMS BY REFERENCE NUMBER

Item **2** is a loop supervisory signal source. It is also called, simply, supervisory signal source. Descriptive labelling on drawings is "SIG."

Item **4** is a loop supervisory current threshold detector device that detects predetermined loop current values, and is thereby able to detect threshold breaches. Throughout this text, any reference to a current detector of any kind refers to this device. Descriptive labelling on drawings is "CUR. DET."

Grouped elements **6** comprise a typical, basic supervised loop.

Grouped elements **6A** comprise a typical, basic supervised loop having multiple, parallelled supervised devices and including a series-connected contact device

so positioned in the loop that it is able to interrupt loop current regardless of the on-hook or off-hook states of the supervised devices.

Grouped elements **6B** comprise a loop similar to loop **6A**, additionally provided with a contact enabled, counter-signal source, parallelled with the supervised devices.

Grouped elements **6C** comprise a loop similar to loop **6A**, additionally provided with a contact enabled, counter-signal source, connected at a sufficient distance from the parallelled supervised devices that a significant component, impedance **8B**, of the total loop impedance separates the counter-signal source from the parallelled supervised devices.

Item **8** represents the total impedance of the illustrated loop in all drawings except **FIG. 4A** and **FIG. 4B**, and excluding that of supervised devices connected to the loop. Typically, this impedance is distributed around the loop.

Items **8A** and **8B** represent, together, the total impedance of loop **6C**, excluding that of the supervised devices connected to the loop. Typically, this impedance is distributed around the loop. Impedance **8A** is intended to represent an arbitrary portion of the total impedance of loop **6C**, and impedance **8B** is intended to represent the remainder.

Item **10** represents a supervised device having supervisory signal circuitry, comprising an impedance and a contact device for opening and closing the loop circuit to place supervised device **10** in its on-hook and off-hook states, respectively. Supervised device **10** is shown in its off-hook state.

Descriptive labelling on drawings is "SUP. DEV."

Item **10A** represents a contact device within supervised device **10** that connects supervised device **10** to loop **6**. When contact device **10A** is closed, supervised device **10** is said to be off-hook. When it is open, supervised device **10** is said to be on-hook.

Item **10B** represents the internal impedance of supervised device **10**.

Item **12** designates the current, typically generated by loop supervisory signal source **2**, that flows through loop current detector **4**.

Item **14** represents a point on the loop between supervisory signal source **2** and current detector **4**.

Points **20A** and **20B** are the two connection points of supervised device **10** to loops **6A**, **6B**, and **6C**.

Item **21** designates the current component of current **12** that flows through supervised device **10**.

Item **22** designates the current component of current **12** that flows through supervised device **24**.

Item **23** represents a contact device so located and connected on loop **6A** that it is capable of generating a hook-flash on the loop, regardless of any number of off-hook, supervised devices connected on that loop. Typically, this contact device is closed, as it is shown. When cycled, it opens, then re-closes.

Item **24** represents an additional supervised device having supervisory signal circuitry comprising an impedance and a contact device for opening and closing the loop circuit to place supervised device **24** in its on-hook and off-hook states, respectively. Supervised device **24** represents each of a number of supervised devices connected on loops **6A**, **6B**, and **6C** in addition to supervised device **10**. Supervised device **24** is shown in its off-hook state. Descriptive labelling on drawings is "SUP .DEV. N"

Item **24A** represents a contact device within supervised device **24** that connects supervised device **24** to the loop. When contact device **24A** is closed, supervised device **24** is said to be off-hook. When it is open, supervised device **24** is said to be on-hook.

Item **24B** represents the internal impedance of supervised device **24**.

Points **30A** and **30B** are the two connection points of supervised device **24** to loop **6**.

Item **32** is a counter-signal source. Descriptive labelling on drawings is "SIG.", overscored.

Item **34** represents a contact device for controlling the connection and disconnection of counter-signal source **32** to the loop. Typically, this contact device is open. When cycled, it closes, then re-opens. It is shown open in **FIG. 3A** and in **FIG. 4A**. It is shown closed in **FIG. 3B** and in **FIG. 4B**.

Item **36** designates the current generated by counter-signal source **32** in **FIG. 3B**.

Item **37** designates the component of current **36** that flows through supervised device **10**.

Item **38** designates the component of current **36** that flows through supervised device **24**.

Points **40A** and **40B** are the two connection points of counter-signal source **32** to loop **6C** in **FIG. 4A** and in **FIG. 4B**.

Item **42** designates the current generated by counter-signal source **32** in **FIG. 4B**.

Item **43** designates the component of current **42** that flows through supervised device **10**.

Item **44** designates the component of current **42** that flows through supervised device **24**.

BACKGROUND OF THE INVENTION - PRIOR ART

The implementation of some features in various telecommunications systems require that a hook-flash be generated. An example on the Public

Switched Telephone Network (PSTN) is three-way calling, also known as conference calling.

Refer to **FIG. 1**. Supervised device **10** is connected to loop **6** in a continuous circuit with supervisory signal source **2**, current detector **4**, and impedance **8**. When contact device **10A** is closed, as it is shown, supervised device **10** is in the off-hook state, and supervisory signal source **2** generates signal current **12** which flows around loop **6** through current detector **4**. When contact device **10A** is cycled, a hook-flash is created in the loop, and the hook-flash is detected by current detector **4**.

Applying only prior art, a hook-flash cannot be generated by a device on a telecommunications loop if another device is off-hook on that loop at the same time.

This can be seen by referring to **FIG. 2**. Supervised device **10** is connected to loop **6A**, completing a circuit with supervisory signal source **2**, current detector **4**, and impedance **8**. In addition, supervised device **24** (typifying any practicable number of such devices) is connected in parallel with supervised device **10**, and contact device **23** has been added in series in loop **6A** in such a manner that it is capable of interrupting all current flowing through current detector **4** when it is opened.

When contact device **10A** and contact device **24A**, in addition to contact device **23**, are all closed, as they are shown, supervised device **10** and supervised device **24** are each in the off-hook state, and supervisory signal source **2** generates signal current **12**, which flows around loop **6A** through current detector **4**. Signal current **12** then splits into component **21**, which flows through supervised device **10**, and component **22**, which flows through supervised device **24**.

A hook-flash cannot be created in the loop by individually cycling either contact device **10A** or contact device **24A**, because the magnitude of the signal current through current detector **4** and the remaining off-hook device is sufficient to prevent a detection breach in loop **6A**.

It is possible, however, to generate a hook-flash in loop **6A**. When contact device **23** is cycled, a hook-flash is created in the loop, because a threshhold breach is created when all current through current detector **4** is cut off.

Unfortunately, if installed in a typical PSTN telephone loop, contact device **23** would have to be installed in series in that loop between all supervised devices connected to the loop and current detector **4**. It cannot simply be plugged into any available jack in parallel with the loop's supervised devices, or it will not be capable of generating a hook-flash, as has just been shown. The ability to make such an installation cannot reasonably be expected of most persons not skilled in electrical or telephony work. Consequently, services and features requiring hook-flash generation under the off-hook loop conditions described can only be implemented by dispatching a skilled installer, at significant expense, to install contact device **23**. This is a definite disadvantage to marketers of such features and services, because the added expense can be sufficient to make the feature or service unfeasible.

It is a goal of this invention to describe a means for, and method of, simulating a hook-flash on a supervisory loop when connected to that loop at any point on the other side of current detector **4** from supervised signal source **2**, not in series with, and regardless of the presence of, any practicable number of off-hook supervised devices also connected to that loop, and without having to open the loop to do so.

Such a device might then be installed by simply plugging it into any convenient, available jack in parallel with one or more telephony supervised devices. Typically, an unskilled person would be able to install such a device. Consequently, services and features requiring hook-flash initiation would then be implementable and marketable by simply mailing such a device to the end user with a set of instructions, eliminating the need to dispatch a skilled installer, at much greater expense, to that end user's installation site.

DETAILED DESCRIPTION AND PREFERRED EMBODIMENT

In **FIG. 3A**, loop **6B** is illustrated. Loop **6B** is similar to loop **6A** in **FIG. 2**, except contact device **23** has been eliminated, and counter-signal

source **32**, in series with contact device **34**, has been added in parallel with supervised device **10** and supervised device **24** and on the other side of current detector **4** from supervised signal source **2**.

When contact device **10A** and contact device **24A** are closed, as they are shown, supervised device **10** and supervised device **24** are each in the off-hook state. Loop **6A** is thereby completed, and supervisory signal source **2** generates signal current **12**, which flows around loop **6A** through current detector **4**, then splits into current component **21**, which flows through supervised device **10**, and current component **22**, which flows through current device **24**.

A hook-flash cannot be created in the loop by individually cycling either contact device **10A** or contact device **24A**, because the magnitude of the signal current through current detector **4** and the remaining device is sufficient to prevent a detection breach in loop **6A**.

In FIG. **3B**, contact device **34** is closed, and counter-signal source **32** is connected to the loop. For a counter-signal source that is precisely matched to the supervisory signal source, the magnitude of counter-signal source **32** is always exactly equal, but opposite, to the magnitude of signal source **2**. Under such conditions, Kirchoff's Second Law dictates that there can be no current flow through current detector **4**. Hence a threshold breach occurs, and a hook-flash is created on the loop.

FIG. **3A** depicts loop **6B** when counter-signal source **32** is not connected to the loop. Under the conditions illustrated, maximum current will flow around the loop and through current detector **4**.

Typically, the maximum value of PSTN loop currents is about 6 times the minimum value, and the loop current threshold is about 3/4 of the minimum. Hence, if I represents the detection threshold current value, then the maximum value of any PSTN loop current will be $8I$. In the following analyses, let E represent the voltage of supervisory signal source **2**, and E_c represent that of counter-signal source **32**.

For a counter-signal source that is not precisely matched to the supervisory signal source, it will be evident to the reader that the value of current I_2 will always be directly proportional to the algebraic sum of the voltages generated by supervisory signal source 2 and counter-signal source 32. Hence, for values of E_c that are less than E :

$$I/(E-E_c) = 8I/(E-0)$$

which can be simplified to:

$$E_c = (7/8)E$$

For a DC supervisory signal, when current detector 2 does not differentiate between a current flow in one direction as opposed to the other, it is also important to determine the maximum voltage that can be output by counter-signal source 32. For values of E_c greater than E , loop current will flow in the opposite direction than for values of E_c less than E . Consequently, the value of I will be negative, while the value of $8I$ will remain positive, and:

$$-I/(E-E_c) = 8I/(E-0)$$

which can be simplified to:

$$E_c = (9/8)E$$

These two limits equations can be combined into the following PSTN tolerance specification for an effective counter-signal source:

$$E_c = E (+/-) (1/8)E$$

which can also be expressed as:

$$E_c = E (+/-) 12.5\%$$

This is a highly practicable specification. Typically, supervisory signal source 2, on the PSTN, outputs a supervisory signal of 48VDC +/- 2DCV, a tolerance of (+/-)4.2%. A very great number of power supplies, produced to

meet this standard, are available on the market at low cost due to their high availability. Yet, to be effective, counter-signal source **32** must output a signal of 48VDC (+/-) 12.5%, a significantly less stringent specification.

The maximum current around loop **6B** in **FIG. 3** is precisely identical to that around loop **6C** in **FIG. 4**, because loop **6B** is precisely identical to loop **6C** when contact device **34** is open, disconnecting signal source **32** from the loop.

Similarly, for a counter-signal source that is precisely matched to the supervisory signal source, the magnitude of counter-signal source **32** is always exactly equal, but opposite, to the magnitude of signal source **2**. As was true for **FIG. 3B**, under such conditions, Kirchoff's Second Law dictates that there can be no current flow through current detector **4**. Hence a threshold breach occurs, and a hook-flash is created on the loop.

The same subsequent reasoning that was applied to **FIG. 3B** will result in precisely the same PSTN tolerance statement for **FIG. 4B**:

$$E_c = E \text{ (+/-) } (1/8)E$$

Hence, **FIG. 4A** and **FIG. 4B** illustrate that, essentially, it doesn't matter where counter-signal source **32** is connected to a loop. The result will be the same: such means and method will simulate a hook-flash on a supervisory loop when connected to that loop at any point on the other side of current detector **4** from supervised signal source **2**, not in series with, and regardless of the presence of, any practicable number of off-hook supervised devices also connected to that loop, and without having to open the loop to do so.

Such means and method can be implemented by simply plugging such means into any convenient, available jack in parallel with one or more telephony supervised devices. Typically, an unskilled person would be able to install such means. Consequently, services and features requiring hook-flash initiation would then be implementable and marketable by simply mailing such means to the end user with a set of instructions, eliminating the need to dispatch a skilled installer, at much greater expense, to that end user's installation site.

In addition, it will be apparent to the reader that contact device **34** can be a manually- or automatically-operated circuit opening-and-closing means. One example of such a manually-operated circuit opening-and-closing means is a pushbutton, cycled by a person. One example of an automatically-operated circuit opening-and-closing means is an electrical relay. Such a relay would operate in response to the occurrence of an event, and would be cycled by associated controlling means and method. One example of such an event is the generation of a signal, transmitted over the PSTN, for the purpose of causing a hook-flash in the loop at the receiving end. Neither the controlling means and method nor the signalling means and method are a part of this invention, but can be accomplished by any of a wide variety of means and methods currently available on the market.